

## CLAIMS

I/We claim:

- [c1]           1.     An apparatus for handling microelectronic workpieces, comprising:  
an input/output station configured to removably receive microelectronic workpieces at an input/output location;  
a pre-process station configured to identify and/or align the microelectronic workpieces;  
at least one process station spaced apart from the pre-process station and the input/output station;  
a first transfer device movably positioned proximate to the input/output station, the first transfer device being configured to move the microelectronic workpieces directly between the input/output location and the pre-process station; and  
a second transfer device movably positioned proximate to the at least one process station, the second transfer device being configured to move the microelectronic workpieces directly between the pre-process station and the at least one process station.
- [c2]           2.     The apparatus of claim 1, further comprising an enclosure having at least one aperture and being disposed at least partially around the at least one process station, and wherein the input/output station is configured to receive microelectronic workpieces through the at least one aperture in the enclosure.
- [c3]           3.     The apparatus of claim 1 wherein the first transfer device includes a first automatic robot and the second transfer device includes a second automatic robot.

[c4]           4.       The apparatus of claim 1, further comprising a storage station having a plurality of workpiece supports, with each workpiece support being positioned to carry a microelectronic workpiece before processing, after processing or both before and after processing, wherein at least a portion of one of the pre-process station and the storage station overlaps at least a portion of the other of the pre-process station and the storage station.

[c5]           5.       The apparatus of claim 1, further comprising a storage station having a plurality of workpiece supports, with each workpiece support being positioned to carry a microelectronic workpiece before processing, after processing or both before and after processing, and wherein the storage station and the pre-process station together form a transfer station.

[c6]           6.       The apparatus of claim 1 wherein the pre-process station includes a first workpiece support positioned to carry a microelectronic workpiece, and wherein the apparatus further comprises a storage station having a plurality of second workpiece supports, with each second workpiece support being positioned to carry a microelectronic workpiece before processing, after processing or both before and after processing, and wherein the first and second workpiece supports are positioned to support coaxially located microelectronic workpieces.

[c7]           7.       The apparatus of claim 1 wherein the input/output station includes a plurality of container supports, with each container support configured to releasably carrier a container of microelectronic workpieces.

[c8]           8.       The apparatus of claim 1 wherein the pre-process station is one of at least two pre-process stations, and wherein the first transfer device is one of at least two first transfer devices.

- [c9] 9. The apparatus of claim 1 wherein the pre-process station includes a sensor positioned to detect an identifying characteristic of the microelectronic workpieces.
- [c10] 10. The apparatus of claim 1 wherein the at least one process station is configured to apply a conductive material to the microelectronic workpieces.
- [c11] 11. The apparatus of claim 1 wherein the at least one process station includes at least one of a metrology station, a material application station, a cleaning station, an etching station and an annealing station.
- [c12] 12. An apparatus for processing microelectronic workpieces, comprising:  
at least one process station configured to carry a microelectronic workpiece during processing;  
a pre-process station configured to identify and/or align the microelectronic workpiece; and  
a storage station having a plurality of workpiece supports, with each workpiece support being positioned to carry a microelectronic workpiece before processing, after processing or both before and after processing, wherein at least a portion of one of the pre-process station and the storage station overlaps at least a portion of the other of the pre-process station and the storage station.
- [c13] 13. The apparatus of claim 12 wherein each workpiece support includes a plurality of support posts, and wherein each support post includes a contact surface positioned to contact a peripheral region of the microelectronic workpiece.
- [c14] 14. The apparatus of claim 12, further comprising:  
an enclosure having at least one aperture and being disposed at least partially around the at least one process station; and

an input/output station configured to receive microelectronic workpieces through the at least one aperture in the enclosure.

- [c15] 15. The apparatus of claim 12, further comprising:  
an input/output station configured to removably receive a plurality of microelectronic workpieces at an input/output location;  
a first transfer device movably positioned proximate to the input/output station, the first transfer device being configured to move the microelectronic workpieces directly between the input/output location and the pre-process station; and  
a second transfer device movably positioned proximate to the at least one process station, the second transfer device being configured to move the microelectronic workpieces directly between the pre-process station and the at least one process station.

- [c16] 16. The apparatus of claim 12 wherein the pre-process station includes a first workpiece support positioned to carry a microelectronic workpiece, and wherein the apparatus further comprises a storage station having a plurality of second workpiece supports, with each second workpiece support being positioned to carry a microelectronic workpiece before processing, after processing or both before and after processing, and wherein the first and second workpiece supports are positioned to support coaxially located microelectronic workpieces.

- [c17] 17. The apparatus of claim 12 wherein the pre-process station is one of at least two pre-process stations and wherein the storage station is one of at least two storage stations.

- [c18] 18. The apparatus of claim 12 wherein the pre-process station includes a sensor positioned to detect an identifying characteristic of the microelectronic workpiece.

[c19] 19. The apparatus of claim 12 wherein the at least one process station is configured to apply a conductive material to the microelectronic workpiece.

[c20] 20. An apparatus for handling microelectronic workpieces, comprising:  
at least one process station configured to carry a microelectronic workpiece during processing;  
a pre-process station configured to identify and/or align microelectronic workpieces at a first workpiece location with the microelectronic workpieces in a first workpiece plane; and  
a storage station having a plurality of workpiece supports, each positioned to carry a microelectronic workpiece in a corresponding second workpiece location with the microelectronic workpiece in a second workpiece plane before processing, after processing or both before and after processing the microelectronic workpiece, wherein the first and second workpiece locations are coaxial along an axis generally normal to at least one of the workpiece planes.

[c21] 21. The apparatus of claim 20 wherein the workpiece supports are first workpiece supports positioned to carry a first microelectronic workpiece centered on the axis, and wherein the pre-process station includes a second workpiece support configured to carry a second microelectronic workpiece centered on the axis.

[c22] 22. The apparatus of claim 20 wherein each workpiece support includes a plurality of support posts, and wherein each support post includes a contact surface positioned to contact a peripheral region of the microelectronic workpiece.

[c23] 23. The apparatus of claim 20, further comprising:  
an enclosure disposed at least partially around the at least one process station; and

an input/output station configured to receive microelectronic workpieces through an aperture in the enclosure.

[c24] 24. The apparatus of claim 20, further comprising:  
an input/output station configured to removably receive microelectronic workpieces at an input/output location;  
a first transfer device movably positioned proximate to the input/output station, the first transfer device being configured to move the microelectronic workpieces directly between the input/output location and the pre-process station; and  
a second transfer device movably positioned proximate to the at least one process station, the second transfer device being configured to move the microelectronic workpieces directly between the pre-process station and the at least one process station.

[c25] 25. The apparatus of claim 20 wherein the pre-process station is one of at least two pre-process stations and wherein the storage station is one of at least two storage stations.

[c26] 26. The apparatus of claim 20 wherein the pre-process station includes a sensor positioned to detect an identifying characteristic of the microelectronic workpiece.

[c27] 27. The apparatus of claim 20 wherein the at least one process station is configured to apply a conductive material to the microelectronic workpiece.

[c28] 28. An apparatus for handling microelectronic workpieces, comprising:  
at least one process station configured to carry a microelectronic workpiece during processing;

a pre-process station configured to identify and/or align microelectronic workpieces, the pre-process station having a first footprint; and  
a storage station having a plurality of workpiece supports, with each workpiece support being positioned to carry a microelectronic workpiece before processing, after processing or both before and after processing the microelectronic workpiece, the storage station having a second footprint, wherein at least a portion of at least one of the first and second footprints overlaps at least a portion of the other of the first and second footprints.

[c29] 29. The apparatus of claim 28 wherein the workpiece supports are first workpiece supports positioned to carry first microelectronic workpieces centered on an axis, and wherein the pre-process station includes a second workpiece support configured to carry a second microelectronic workpiece centered on the same axis.

[c30] 30. The apparatus of claim 28 wherein each workpiece support includes a plurality of support posts, and wherein each support post includes a contact surface positioned to contact a peripheral region of the microelectronic workpiece.

[c31] 31. The apparatus of claim 28, further comprising:  
an enclosure disposed at least partially around the at least one process station; and  
an input/output station configured to receive microelectronic workpieces through an aperture in the enclosure.

[c32] 32. The apparatus of claim 28, further comprising:  
an input/output station configured to removably receive a plurality of microelectronic workpieces at an input/output location;

a first transfer device movably positioned proximate to the input/output station, the first transfer device being configured to move the microelectronic workpieces directly between the input/output location and the pre-process station; and

a second transfer device movably positioned proximate to the at least one process station, the second transfer device being configured to move the microelectronic workpieces directly between the pre-process station and the at least one process station.

[c33] 33. The apparatus of claim 28 wherein the pre-process station is one of at least two pre-process stations and wherein the storage station is one of at least two storage stations.

[c34] 34. The apparatus of claim 28 wherein the pre-process station includes a sensor positioned to detect an identifying characteristic of the microelectronic workpiece.

[c35] 35. The apparatus of claim 28 wherein the at least one process station is configured to apply a conductive material to the microelectronic workpiece.

[c36] 36. An apparatus for handling microelectronic workpieces, comprising:

- a plurality of workpiece processing stations;
- an enclosure at least partially enclosing the plurality of workpiece processing stations;
- an input/output station configured to removably receive microelectronic workpieces at an input/output location from a region external to the enclosure;
- a pre-process station configured to identify and/or align microelectronic workpieces at a first workpiece location, the pre-process station having a first footprint;



- a storage station having a plurality of workpiece supports, with each workpiece support being positioned to carry a microelectronic workpiece at a second workpiece location before processing, after processing or both before and after processing the microelectronic workpiece, the storage station having a second footprint, wherein at least a portion of at least one of the first and second footprints overlaps at least a portion of the other of the first and second footprints and wherein the first and second workpiece locations are coaxial;
- a first transfer device movably positioned proximate to the input/output station, the first transfer device being configured to move microelectronic workpieces directly between the input/output location and the pre-process station, the first transfer device further being configured to move microelectronic workpieces directly between the input/output location and the storage station; and
- a second transfer device movably positioned proximate to the process stations, the second transfer device being configured to move the microelectronic workpieces directly between the pre-process station and the at least one process station.

[c37] 37. The apparatus of claim 36 wherein each workpiece support includes a plurality of support posts, and wherein each support post includes a contact surface positioned to contact a peripheral region of the microelectronic workpiece.

[c38] 38. The apparatus of claim 36 wherein the pre-process station is one of at least two pre-process stations and wherein the storage station is one of at least two storage stations.

- [c39] 39. The apparatus of claim 36 wherein the pre-process station includes a sensor positioned to detect an identifying characteristic of the microelectronic workpiece.
- [c40] 40. The apparatus of claim 36 wherein the at least one process station is configured to apply a conductive material to the microelectronic workpiece.
- [c41] 41. An apparatus for handling microelectronic workpieces, comprising:  
an input/output station configured to removably receive microelectronic workpieces at an input/output location;  
a storage station spaced apart from the input/output location and configured to carry a plurality of microelectronic workpieces;  
at least one process station spaced apart from the storage station and the input/output station;  
a first transfer device movably positioned proximate to the input/output station, the first transfer device being configured to move the microelectronic workpieces directly between the input/output location and the storage station; and  
a second transfer device movably positioned proximate to the at least one process station, the second transfer device being configured to move the microelectronic workpieces directly between the storage station and the at least one process station.
- [c42] 42. The apparatus of claim 41, further comprising an enclosure having at least one aperture and being disposed at least partially around the at least one process station, and wherein the input/output station is configured to receive microelectronic workpieces through at least one aperture in the enclosure.

[c43] 43. The apparatus of claim 41 wherein the first transfer device includes a first automatic robot and the second transfer device includes a second automatic robot.

[c44] 44. The apparatus of claim 41, further comprising a pre-process station configured to carry a microelectronic workpiece and identify and/or align the microelectronic workpiece, wherein at least a portion of one of the pre-process station and the storage station overlaps the other of the pre-process station and the storage station.

[c45] 45. The apparatus of claim 41 wherein the storage station includes a plurality of first workpiece supports positioned to carry a plurality of microelectronic workpieces, and wherein the apparatus further comprises a pre-process station configured to identify and/or align a microelectronic workpiece, the pre-process station further having a second workpiece support, and wherein the first and second workpiece supports are positioned to carry microelectronic workpieces coaxially.

[c46] 46. The apparatus of claim 41 wherein the at least one process station is configured to apply a conductive material to the microelectronic workpiece.

[c47] 47. A method for handling microelectronic workpieces, comprising:  
receiving microelectronic workpieces at an input/output location of a process tool;  
transferring at least one of the microelectronic workpieces directly from the input/output location to a pre-process station with a first transfer device;  
identifying and/or aligning the microelectronic workpiece at the pre-process station; and

transferring the at least one microelectronic workpiece directly from the pre-process station to a process station with a second transfer device.

[c48] 48. The method of claim 47 wherein the process tool includes an enclosure disposed at least partially around the process station, and wherein the method further comprises receiving the microelectronic workpieces through an aperture in the enclosure.

[c49] 49. The method of claim 47 wherein transferring at least one of the microelectronic workpieces directly from the input/output station includes transferring the at least one microelectronic workpiece with a first automatic robot and wherein transferring at least one of the microelectronic workpieces directly from the pre-process station includes transferring the at least one microelectronic workpiece with a second automatic robot.

[c50] 50. The method of claim 47 wherein transferring at least one of the microelectronic workpieces directly from the input/output location to a pre-process station includes transferring the at least one microelectronic workpiece to a pre-process station that is positioned at least partially over or under a storage station, with the storage station configured to removably and simultaneously carry a plurality of microelectronic workpieces.

[c51] 51. The method of claim 47 wherein transferring at least one of the microelectronic workpieces directly from the input/output location to a pre-process station includes transferring the at least one microelectronic workpiece to a first workpiece support axially aligned with a plurality of second workpiece supports of a storage station, with each second workpiece support being positioned to carry a microelectronic workpiece before processing, after processing or both before and after processing the microelectronic workpiece.

- [c52]            52.    The method of claim 47, further comprising detecting an identifying characteristic of the microelectronic workpiece at the pre-process station.
- [c53]            53.    The method of claim 47, further comprising applying a conductive material to the microelectronic workpiece at the process station.
- [c54]            54.    A method for handling microelectronic workpieces, comprising:  
receiving a plurality of microelectronic workpieces at an input/output location of a process tool;  
transferring at least a first microelectronic workpiece directly from the input/output location to a pre-process station, with a transfer device, by moving the transfer device to a first position in a first plane generally aligned with the first microelectronic workpiece at the pre-process station; and  
transferring at least a second microelectronic workpiece directly from the input/output location to a storage station, with the transfer device, by moving the transfer device to a second position in a second plane generally aligned with the second microelectronic workpiece at the storage station, the second plane being offset from and generally parallel to the first plane, with at least one of the storage station and the pre-process station at least partially overlapping the other.
- [c55]            55.    The method of claim 54, wherein transferring at least a first microelectronic workpiece includes transferring the first microelectronic workpiece to a first support position, and wherein transferring at least a second microelectronic workpiece includes transferring the second microelectronic workpiece to a second support position axially aligned above or below the first support position.

- [c56]            56.    A method for handling microelectronic workpieces, comprising:  
receiving microelectronic workpieces at an input/output location of a  
process tool;  
transferring a first one of the microelectronic workpieces directly from the  
input/output station to a storage station, with a first transfer device;  
transferring a second one of the microelectronic workpieces directly from  
the input/output station to the storage station, with the first transfer  
device, while the first microelectronic workpiece is positioned at the  
storage station; and  
transferring at least one of the first and second microelectronic workpieces  
directly from the storage station to a process station, with a second  
transfer device.
- [c57]            57.    The method of claim 56 wherein the process tool includes an  
enclosure disposed at least partially around the process station, and wherein the  
method further comprises moving the microelectronic workpieces through an  
aperture in the enclosure.
- [c58]            58.    The method of claim 56 wherein transferring at least one of the  
microelectronic workpieces directly from the input/output location includes  
transferring the at least one microelectronic workpiece with a first automatic robot  
and wherein transferring at least one of the microelectronic workpieces directly  
from the storage station includes transferring the at least one microelectronic  
workpiece with a second automatic robot.
- [c59]            59.    The method of claim 56 wherein transferring at least one of the  
microelectronic workpieces directly from the input/output station to a storage  
station includes transferring the at least one microelectronic workpiece to a  
storage station that is positioned at least partially over or under a pre-process  
station configured to identify and/or align microelectronic workpieces.